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MODULAR SIMULATOR SYSTEM (MSS)

SYSTEM/SEGMENT SPECIFICATION FOR THE GENERIC MODULAR SIMULATOR SYSTEM - VISUAL MODULE

VOLUME 11

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AUGUST 1993

FINAL REPORT

SYSTEMS ENGINEERING DIVISION
AERONAUTICAL SYSTEMS CENTER
AIR FORCE MATERIEL COMMAND
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This technical report has been reviewed and is approved for publication.

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13. ABSTRACT *(Maximum 200 words)*

This is the Visual portion of the generic Modular Simulator System (MSS) specification. It is designed to be tailored to specify the requirements for a specific aircraft training device or family of aircraft training devices. This specification contains specific tailoring instructions for each paragraph. When the tailoring process is complete, the italicized tailoring instructions should have been replaced by application specific text or deleted from the specification. It is suggested that the user read the "Modular Simulator Engineering Guide" and the "Modular Simulator Management Guide" prior to tailoring this volume.

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TABLE OF CONTENTS

TABLE OF CONTENTS (Contd)

TABLE OF CONTENTS (Contd)

LIST OF FIGURES

PREFACE

This generic Modular Simulator System (MSS) segment specification has been developed in accordance with DI-CMAN-80008A; Data Item Description for System/Segment Specifications. This specification meets or exceeds the requirements for MIL-STD-490, Type A, specification. This specification is designed to be tailored to specify the requirements for a specific aircraft training device or family of aircraft training devices. Training devices may consist of Weapons System Trainers (WST), Operational Flight Trainers (OFT), Cockpit Procedures Trainers (CPT), Part Task Trainers (PTT), etc.

Tailoring will be necessary to meet specific application requirements. The tailoring must be accomplished so as not to violate the goals and intent of the MSS concept. It is assumed that the user of this document has a familiarity with MSS design concepts and architecture, the application aircraft training requirements, and general working knowledge of aircraft training systems. It is suggested that the user read the "Modular Simulator System Engineering Design Guide" (D495-10440-1) and the "Modular Simulator System Management Guide" (D495-10439-1) prior to tailoring this specification. These guides provide an overview of the MSS architecture, an in-depth discussion on its application, and lessons learned from previous applications.

Each segment in the MSS architecture provides a portion of the overall system functionality. Similar functions and operations were grouped in each segment based on past experience, areas of design expertise, and management of intersegment communication. To promote reuse of the segments and gain the maximum benefits of using the MSS approach, it is suggested that the user adhere to the generic functional allocation. Interfaces between segments should remain relatively constant from application to application. The application vehicle is considered to be an air vehicle (e.g. fixed wing, variable geometry, or rotary wing.), although the MSS architecture and concepts may be applied to either ground or sea vehicles.

This specification contains specific tailoring instructions for each paragraph. The instructions are contained within the paragraphs, and are identified by blank spaces and/or italicized text. When the tailoring process is complete, the italicized tailoring instructions should have been replaced by application specific text or deleted from the specification. Paragraphs which do not apply to a particular application should not be deleted. They should be identified as "Not Applicable" to maintain paragraph numbering consistency between volumes and various MSS applications.

1. SCOPE

1.1 Identification. This segment specification establishes the requirements for the Visual segment of the _____*(insert application aircraft type)* Modular Simulator System (MSS). This volume is one of _____*(insert number of volumes in the application system/segment specification)* volumes which comprise the system/segment specification for the_____ *(insert application aircraft type)* MSS. Volume I of this specification contains system level requirements such as MSS structure, communication architecture, network interface performance, system level diagnostic and test requirements, Ada programming language applicability, adaptability and expansibility, and other requirements which pertain to all volumes.

1.2 System Overview. The Visual segment simulates the Visual functions for the _____*(insert application aircraft type)* MSS. The Visual functions provide the trainee visual out-the-window references and cues relating to the tactical and natural environments through which the _____*(insert application aircraft type)* is operating. The Visual segment may also provide visual cues for profile type view equipment such as Forward Looking Infrared (FLIR) or Infrared Search and Track (IRST). The Visual functions receive descriptions of the Visual environment from other segments which are utilized to provide the trainee the visual cues and scene content required to accomplish mission related tasks. The Visual segment interfaces with the other MSS segments as described in the _____*(insert application aircraft type)* MSS Interface Design Document (IDD), _____*(insert IDD document number)*. Each of the Visual segment functions identified are processed within the Visual segment.

1.3 Document Overview. This segment specification defines Visual segment unique requirements for the _____*(insert application aircraft type)* MSS. It contains requirements for the functions performed within the segment communication interface requirements, segment performance requirements, segment diagnostic and test requirements, and expansibility and adaptability requirements as applicable to the Visual segment.

2. APPLICABLE DOCUMENTS

2.1 Government Documents. The following documents of the exact issue shown form a part of this specification to the extent specified herein. In the event of conflict between the documents referenced herein and the contents of this specification, the contents of this specification shall be considered a superseding requirement.

The Government documents which are applicable to the entire _____*(insert application aircraft type)* MSS are listed in Volume I of this specification. The following Government documents are in addition to those documents and specifically applicable to the _____*(insert application aircraft type)* Visual segment.

SPECIFICATIONS:

Federal - *(Identify applicable federal specifications)*
Military - *(Identify applicable military specifications)*
Other Government Agency - *(Identify applicable government specifications)*

STANDARDS:

Federal - *(Identify applicable federal standards)*
Military - *(Identify applicable military standards)*
Other Government Agency - *(Identify applicable government standards)*

DRAWINGS: *(Identify applicable drawings)*

OTHER PUBLICATIONS:

Manuals - *(Identify applicable manuals)*
Regulations - *(Identify applicable regulations)*
Handbooks - *(Identify applicable handbooks)*
Bulletins - *(Identify applicable bulletins)*

Copies of specifications, standards, drawings, and publications required by suppliers in connection with specified procurement functions should be obtained from the contracting agency or as directed by the contracting officer.

(In this paragraph, list only those documents which are explicitly referenced within this specification volume. If a requirement paragraph is tailored to reference a system/segment specification Volume I paragraph, and that paragraph contains a reference, the document should not be listed here. All requirements and references in system/segment specification Volume I are requirements of this specification unless specifically excluded in this volume.)

2.2 Non-Government Documents. The following documents of the exact issue shown form a part of this specification to the extent

specified herein. In the event of conflict between the documents referenced herein and the contents of this specification, the contents of this specification shall be considered a superseding requirement.

The non-Government documents which are applicable to the entire _____*(insert application aircraft type)* MSS are listed in Volume I of the System/Segment Specification. The following non-Government documents are in addition to those documents and specifically applicable to the _____*(insert application aircraft type)* MSS Visual segment.

SPECIFICATIONS: *(Identify applicable non-government specifications)*
STANDARDS: *(Identify applicable non-government standards)*
DRAWINGS: *(Identify applicable non-government drawings)*
OTHER PUBLICATIONS: *(Identify applicable non-government publications)*

Technical Society and technical association specifications and standards are generally available for reference from libraries. They are also distributed among technical groups and using Federal Agencies.

(In this paragraph, list only those documents which are explicitly referenced within this specification volume. If a requirement paragraph is tailored to reference a system/segment specification Volume I paragraph, and that paragraph contains a reference, the document should not be listed here. All requirements and references in system/segment specification Volume I are requirements of this specification unless specifically excluded in this volume.)

3. SEGMENT REQUIREMENTS

3.1 Segment Definition. The Visual segment provides the simulation of out-the-window references and cues required by the _____*(insert application aircraft type)* MSS crew station participants. Simulation of sensory functions is also performed when appropriate (e.g. Forward Looking Infrared (FLIR), Infrared Search and Track (IRST), etc.). The Visual segment is one of _____*(number of segments used in the application simulation)* unique segments which comprise the _____*(insert application aircraft type)* MSS. The Visual segment shall provide the modes, states, and functions as defined in this specification volume and Volume I.

(This paragraph should be tailored to convey the exact top level functions required of the segment. For example, the purpose of the visual segment may be solely to provide the out-the-window scenes as viewed by the pilot(s) in the crew station. If this is the case, then any reference to sensory functions (FLIR, IRST, etc.) should be deleted from the segment definition. If this segment is to be used/reused on several devices within a family of trainers, that should be stated here with any unique performance requirements.)

3.2 Characteristics

3.2.1 Performance Characteristics. Performance of the Visual segment shall be as specified herein and in accordance with the _____*(insert application aircraft type)* design criteria. The fidelity of the Visual segment shall be sufficient to provide the trainee with the visual cues and scene content to allow for the necessary level of training as specified in Volume I, paragraph 6 of this specification.

(Additional text should be added to this paragraph to identify the design criteria and specific Visual segment components. It is important to limit the subjective evaluation of visual systems by defining an objective class of training performance requirements, implemented as a finite set of visual cues and features. This paragraph should define the specific training/simulation objectives of the visual system and lead into detailed objectives in subsequent paragraphs. All the performance attributes then become indirectly associated with accomplishing training tasks as opposed to technical objectives. A general statement with respect to the fidelity of the simulation should also be added)

3.2.1.1 Segment Modes and States. The Visual segment shall support the system modes and states as described in Volume I of this specification. Additional requirements, or operations specific to the Visual segment shall not cause degradation of the system nor violate the intent of the system level mode or state.

(Introduction of new modes is prohibited. Functions should be accomplished within the established modes and states. This paragraph should be tailored to describe the segment's specific response to a given mode or state. Subparagraphs should be added to identify and define unique segment requirements for each mode and state. An example would be that, during

the Reset Mode, the Visual display shall blank and the Image Generator shall reinitialize to the initial conditions associated with a default mission.)

3.2.1.2 Visual Segment Functions. Functions characterized as "Implemented" shall be implemented to the extent described by the paragraphs dedicated to those functions. Functions characterized as "Not Applicable" shall not exist in this simulation of the _____*(insert application aircraft type)*, and are not required to be implemented in any form within the Visual segment.

a.	Visual Support Function	Implemented
b.	Image Generation Function	*(Implemented, N/A)*
c.	Moving Models Function	*(Implemented, N/A)*
d.	Visual Database Function	*(Implemented, N/A)*
e.	Visual Scene Environment Function	*(Implemented, N/A)*
f.	Lighting Control Function	*(Implemented, N/A)*
g.	Spati. Relations Function	*(Implemented, N/A)*
h.	Occulting Function	*(Implemented, N/A)*
i.	Mission Computer/Display Processor Interface Function	*(Implemented, N/A)*
j.	Visual Crew Station Interfacing Function	*(Implemented, N/A)*
k.	Visual Aircraft Systems Interface Function	*(Implemented, N/A)*
l.	Visual Display Systems Function	*(Implemented, N/A)*

(Each function listed should be characterized as "Implemented" or "Not Applicable (NA)".)

3.2.1.2.1 Visual Support Function. The Visual support function shall provide the segment unique support services required for the operation of the Visual segment in the MSS environment. The Visual support function services shall include the functions listed below, and as described in the following paragraphs.

a. Executive Control
b. Initialization
c. MSS Virtual Network (VNET) Communication
d. Diagnostics and Test
e. Backdoor Interfacing
f. Malfunctions
g. Damage Assessment
h. Security Processing
i Scoring
j. Other Support Function Services

(Service functions are usually incidental to the simulation but no less critical. Examples are overhead and Input/Output (I/O) functions. Additional services may be added as necessary to meet specific application requirements. If so, corresponding subparagraphs must be added below. Do not reuse paragraphs for support services that are not applicable.)

3.2.1.2.1.1 Executive Control. The executive control support service shall provide operational control for the Visual segment. This control shall include execution sequencing of all software, mode and state control, and communication between the simulation software and the VNET.

(If additional or specific executive control functions are required, they should be identified in this paragraph. An example might be Visual segment specific information such as communications between the Host Computer and the Image Generator.)

3.2.1.2.1.2 Initialization. The initialization support service shall control initial hardware and software states for the Visual segment. System initialization shall occur during power-up and system resets, as defined in Volume I of this specification. The initialization function shall also access mission initialization data, and transfer the data to other segment functions for Mission initialization.

(Initialization requirements unique to the application aircraft Visual segment should be specified in this paragraph. Initialization refers to setting initial hardware and software states during power-up and system resets as defined in Volume I. Scale factors and default settings (usually powered off) are typically initialized by this function. A second initialization function is to access mission initialization data (for example from disc) to pass to other segment functions for mission initialization. Examples of Visual initialization parameters would be the aircraft position (on the tarmac, on the runway, etc.) or time of day lighting conditions (dawn, daylight, dusk, night)).

3.2.1.2.1.2.1 Image Generation Function Initial Conditions. The Image Generation (IG) function shall provide for initialization of the following conditions:

(Initial conditions or default values for the Image Generator should be identified in this paragraph. Some initial conditions that should be considered in this paragraph are the following:

a. Ownship Active Eyepoint (Pilot, Copilot, Nominal)
b. Ownship Attitude
c. Ownship Position
d. Environmental Conditions and Lighting
e. Visual On/Off
f. Latitude/Longitude of Gaming Area)

3.2.1.2.1.2.2 Visual Scene Environment Function Initial Conditions. The Visual Scene Environment function shall provide for the initialization of the following conditions:

(Initial conditions or default values for the environmental scene content should be identified in this paragraph. Some initial conditions that should be considered in this paragraph are the following:

a. Fog
b. Ground Fog
c. Patchy Fog
d. Haze
e. Runway Visual Range (RVR)
f. Blowing Snow
g. Rain Intensity Level
h. Clouds
i. Cloud Tops
j. Cloud Bottoms
k. Scud
l. Horizon Brightness
m. Ice on Runway
n. Snow on Runway
o. Thunderstorm Heading
p. Thunderstorm Library Identifier
q. Thunderstorm Position
r. Thunderstorm Status
s. Dynamic Solar Angle (Time of Day/Time of Year)
t. Smoke)

3.2.1.2.1.2.3 Lighting Control Function Initial Conditions. The Lighting Control function shall provide for initialization of the following parameters and values:

(Initial or default conditions for lighting such as on/off or brightness level should be identified in this paragraph. Some initial conditions that should be considered in this paragraph are the following:

a. Steerable Search Lights (Infrared and Visible)
b. Position Lights
c. Strobe Lights
d. Landing Lights
e. Formation Lights
f. Visual Approach Slope Indicator (VASI) Lights
g. Optical Landing System (OLS) Lights
h. Approach Strobe Lights
i. Runway End Identifier Lights (REIL)
j. General Environmental Light Points
k. Fixed Beacon
l. Rotation Beacon

m. Runway Lights
n. Taxi Lights
o. Sun
p. Stars
q. Moon
r. Fires)

3.2.1.2.1.3 MSS Virtual Network Communication. The MSS VNET communication support service shall provide the Visual segment interface to the MSS VNET. It shall allow communication with other segments in the _____*(insert application aircraft type)* MSS. The Visual segment shall communicate with the MSS VNET in accordance with the protocol requirements defined in the _____*(insert application aircraft type)* MSS Interface Definition Document (IDD), _____*(insert MSS IDD Number)*.

3.2.1.2.1.4 Diagnostics and Test. The diagnostics and test support service shall provide control for the diagnostic and test functions incorporated into the Visual segment. Diagnostic and test requirements shall be in accordance with the requirements specified herein.

(Based upon the specific simulator diagnostic requirements, all or part of the three types of diagnostic capabilities may be required. "Not Applicable" should be inserted if the specific diagnostic type is not required for the application MSS. Specific Diagnostics and their requirements should be listed in each paragraph when applicable.)

3.2.1.2.1.4.1 On-Line Diagnostics. On-line diagnostics shall be provided for the Visual segment. These diagnostics shall be self initiating during start-up and/or they may be executed as a background function during training mode.

(On-line diagnostics are those diagnostics that are executed while the training system is in the real-time training mode. These diagnostics may run as a background task. An example that would be used in an MSS environment might be a segment functional diagnostic. Each segment would tell the IOS segment that it was still functioning on a periodic basis (say once a minute). If the IOS does not receive the message, then it assumes the segment is not functioning properly and provides a message to the instructor.)

3.2.1.2.1.4.2 Off-Line Diagnostics. Off-line diagnostics shall be provided by the Visual segment. Off-line diagnostics shall be executed when the _____*(insert application aircraft type)* is not in a system mode.

(Off-line diagnostics are those diagnostics that are performed on a segment in the stand-alone or segment mode. Typical off-line diagnostics would include hardware self tests, software tests, I/O debug programs, Daily Readiness at a segment level, etc.)

3.2.1.2.1.4.3 Remote Controlled Diagnostics. Remote controlled diagnostics shall be provided for the Visual segment. These diagnostics shall be executable, from the Instructor Operator Station (IOS), when the MSS is in the Remote Controlled Diagnostic mode.

(Remote Controlled Diagnostics are those diagnostics that run in the special remote controlled diagnostic mode. These diagnostics require the system to be up and running and the segments communicating. An example of a remote controlled diagnostic would be a real-time debugger.)

3.2.1.2.1.5 Backdoor Interfacing. The backdoor interface support service shall provide the means to support external interfaces to the Visual segment. All ownship visual system Input/Output (I/O) not specifically identified in the _____*(insert application aircraft type)* MSS IDD shall interface via the MSS VNET. Backdoor interfaces shall not be utilized for normal intersegment communication.

(Specific external interfaces should be identified in this paragraph. The Mission Computer/Display Processor Interface function and the Crew Station Interface function are two areas where backdoor interfaces may be utilized. Backdoor interfaces may include a 1553 bus to communicate with installed aircraft avionics or a specialized interface to drive a Head Up Display (HUD). Also, the Image Generation function may have a backdoor interface with the hardware of other systems such as Ground Map Radar, Weather Radar, or Weapons Systems. A backdoor interface may not be utilized to transmit intersegment data.

The visual segment should communicate to other segments using backdoor interfaces only in the event that the performance parameters of the VNET are not able to support the application specific interface. A typical example might be sending digital image data to the radar segment for radar data. The image data has an extremely high bandwidth which would bog down the VNET interface.)

3.2.1.2.1.6 Malfunctions. The malfunctions support service shall provide the control for the processing and execution of the Visual segment malfunctions. The system response shall be in accordance with the aircraft design criteria.

(Usually, the Visual segment would not have associated malfunctions. However, there are some malfunctions that could apply to the Visual segment such as failed landing/taxi lights, a broken/jammed refueling boom, or a failed/degraded FLIR display. Any applicable Visual segment malfunctions should be defined in a program unique Malfunction Description Document.)

3.2.1.2.1.7 Damage Assessment. The damage assessment support service shall provide for the processing and implementation of any damage simulation for which the Visual segment is responsible. This shall include the degradation of the appropriate systems within the Visual segment based upon the evaluation of the damage severity and location.

(Based upon the training requirements of the application aircraft MSS, any specific damage assessment and system degradation requirements should be specified in this paragraph. Damage Assessment is an advanced requirement which is not often applied to visual systems. Emerging visual systems may have damage assessment requirements that require the visual segment to analyze weapons detonations and modify affected models to reflect the damage. An example might include modifying terrain elevations and texture in the cartographic database to create an impact crater effect in the terrain.)

3.2.1.2.1.8 Security Processing. The Visual segment security processing support service shall provide for the processing of the security requirements of the _____*(insert application aircraft type)* MSS Visual segment.

(This paragraph should be expanded to clearly specify which government directives apply, and to what extent, consistent with security considerations. Security processing could include Memory Erase Mode if required and any other security considerations such as removable memory or special encoding devices.)

3.2.1.2.1.9 Scoring. The scoring support service shall provide the ability to collect specific data for the assessment of a student's performance in his utilization of the Visual cues. The Visual segment scoring data shall be provided to the IOS segment via the MSS VNET.

(Application specific scoring data requirements to the Visual segment shall be listed in this paragraph. If large amounts of data are required, it may be advisable to provide this to the IOS as a non-real-time activity.)

3.2.1.2.1.10 Other Support Function Services. Not Applicable.

(If there are other support functions unique to this segment they should be listed here, otherwise identify this paragraph as" Not Applicable". Intrasegment communication is an example of a function that might be listed in this paragraph. Before defining new functions, be sure the function cannot be incorporated as a variant of an existing function.)

3.2.1.2.2 Image Generation Function. The Image Generation (IG) function shall provide all the visual scene and graphical performance for all OTW and internal station displays. The IG function shall meet the video and data interface format requirements for all displays within the Visual segment. The IG performance characteristic requirements shall be as specified by the following paragraphs.

(The IG function provides the out-the-window visual scene and/or with multiple visual channels, different color tables, and/or other technologies, it may also simulate profile type view equipment for a variety of cockpit sensors such as Forward Looking Infrared (FLIR), Low Light TV (LLTV), and Infrared Search and Track (IRST). The IG paragraph should describe the

primary function of the IG in the system, including a detailed list of capabilities to be provided by the system. The following paragraphs should outline the detailed specifications for each of those capabilities.

The architectures of IGs vary between vendors, therefore it is not always possible to specify systems uniformly. The following subparagraphs describe capabilities which are common to most IGs. The IG capabilities are frequently inter-related. The relationships between capabilities will require performance trade studies to determine which performance features are important to the target application.)

3.2.1.2.2.1 Scene elements. The visual imagery produced by the image generator shall appear as recognizable real-world scenes. These scenes shall be constructed with the scene elements and characteristics discussed below.

(This paragraph provides some basic requirements for the character of the generated image and introduces the following detailed specifications. In most applications, this paragraph will require no tailoring.)

3.2.1.2.2.1.1 Lighting capacity. The image generator shall be capable of generating a minimum of _____ *(specify the total number of lights to be displayed per update frame)* lights per update frame. The types of lights to be generated shall include _____ *(Specify the types of lights to be simulated. This may include isolated light sources, perspective lights, and/or special purpose lights.)* All lights shall vary in brightness as a function of range and visibility. Capability to control these lights shall be provided. Control parameters shall be as defined in the Lighting Control function.

(The number of lights required is dependent upon the training task and the importance of lights to the task. Some systems trade edge or polygon processing capacity for light processing capacity. These requirements may need to be specified on a channel basis in addition to the total scene requirements discussed in the paragraph as written. These requirements also may need to be significantly enhanced for a dusk/night system. Special purpose lights may require dedicated processing for some system types and thus have may limited availability.)

3.2.1.2.2.1.2 Polygon Capacity. The image generator shall process a minimum of _____ *(insert number)* of polygons per second per system. Each channel shall process a minimum of _____ *(insert number)* polygons per update frame. Polygon capacity shall consist of _____ *(insert number)* textured-Phong shaded polygons, _____ *(insert number)* textured-Gouraud shaded polygons, and _____ *(insert number)* untextured-face shaded polygons.

(Polygons are an arbitrary definition of closed 2-dimensional surfaces and will vary from triangles to vertex polygons. The surfaces represent the simplest and most efficient geometry

which can be processed by the IG. The polygon numbers and types are determined by the projected database content, high fidelity polygons in the near field and lower fidelity polygons in the far-range.)

3.2.1.2.2.1.3 Pixel Capacity. The image generator shall be capable of generating _____ *(insert number)* of pixels (picture elements) per second per system. Each channel shall process a minimum of _____ *(insert number)* pixels per update frame. The pixel capacity shall be measured under the minimum polygon mix and capacities described in 3.2.1.2.2.1.2 (Polygon Capacity).

(Pixel capacity describes the total number of pixels which may be produced by the IG. The pixel processing and polygon processing tend to be inversely related. Systems which process large numbers of polygons may be limited by pixel output or vice versa. It essential to understand the IG architecture to be able to evaluate the system limitations.)

3.2.1.2.2.1.4 Anti-Aliasing. The image generator shall provide anti-aliasing for _____ *(Define the IG anti-aliasing capabilities. This may include anti-aliasing for light-points, dynamic objects, everything.)*.

(Aliasing is an artifact caused by the under sampling of the image resolution with respect to the operator's eye. Spatial aliasing is characterized by stair-steps or jagged edges of rendered polygons. Temporal aliasing is characterized by raster crawl, or aliasing which moves with position. Aliasing is most disturbing in high contrast objects, such as light-points, and long, skinny untextured polygons.)

3.2.1.2.2.1.5 Surface Shading. Surface shading or coloring shall be computed as a function of object structure, illumination angle, range from the eyepoint, and visibility limitations. A minimum of _____ *(insert number of shades of grey for a monochrome system, or the number of colors for a color system. Typical values are 256 shades of grey, and at least 256 colors.) shall* be provided. The capability to selectively apply curved surface shading to simulate curved surfaces shall be provided to be used in the presentation of other objects (aircraft, storage tanks, etc.).

(Identify Shading requirements in this paragraph. Shading is specified as types such as face or curved surfaced shading, and polygon or vertex colored. These may be specified in any combination. However curved surface shading should not be imposed for the entire scene as it may represent a significant processing requirement.)

3.2.1.2.2.1.6 Texturing. The image generator shall have the capability to display a minimum of _____ *(Specify the number of texture patterns or types of texture required)* texture patterns simultaneously to provide relative altitude and velocity cues. Texture capability shall be in addition to the edge/surface processing capacity specified herein. Texture patterns shall be assignable to any surface or feature in the visual environment. Texture shall

remain stationary with respect to the surface, and shall maintain the proper perspective, occulting, and contrast/color relationships for the surface.

(Identify texturing requirements in this paragraph. These requirements are dependent upon the tasks to be trained. The number of patterns or types of texture required depend upon the architecture of the image generator. Some calligraphic or low-cost image generators may not support texture at all.)

3.2.1.2.2.1.7 Cultural Features. The image generator shall display appropriate culture features as necessary to train the tasks specified in Volume I, paragraph 6.1, of this specification. There shall be no limitations in the display of cultural features other than the overall IG polygon processing and light capacity as specified herein.

(The purpose of this requirement is to ensure that the IG has adequate capacity to process the cultural features required to train the required tasks. In most applications, this paragraph will require no tailoring.)

3.2.1.2.2.1.8 Terrain. The image generator shall display the appropriate terrain structure as necessary to train the tasks specified in Volume I, paragraph 6.1, of this specification. There shall be no limitations in the display of terrain information other than the overall image generator polygon processing capacity specified herein.

(The purpose of this requirement is to ensure that the image generator has adequate capacity to process the terrain model required to train the required tasks. In most applications, this paragraph will require no tailoring.)

3.2.1.2.2.1.9 Concentration of Scene Detail. The image generator shall be designed such that it concentrates scene detail in the immediate vicinity of the viewpoint or where training requirements dictate. This shall be accomplished as appropriate to the training task without creating distracting visual effects. Transitions from one level of detail to another shall be gradual and shall exhibit no distracting effects.

(This paragraph is required for all IGs and in most applications requires no tailoring. It ensures that the IG devotes a high percentage of its resources to the enhancement of the detail of the near scene with decreasing detail in proportion to the distance from the eyepoint. Two exceptions to the requirement that detail be concentrated near the eyepoint are the air-to-air and air-to-ground scenarios, where detail at some distance from the eyepoint is also required. Any such exceptions should be identified in this paragraph.)

3.2.1.2.2.1.10 Load Management. The image generator shall be designed to constantly monitor and control its own processing load so that a near-capacity load is maintained. The capability to gracefully degrade the simulated imagery to prevent and

recover from overload conditions shall be provided. This shall be accomplished by temporarily reducing the processing load by eliminating scene detail in a structured and non-distracting manner, so that features of minimal importance to the current training task are eliminated or portrayed in lower levels of detail, and features of higher importance are preserved.

(This paragraph is required for all IGs and in most applications requires no tailoring. It ensures that the IG and data base are designed to anticipate and avoid overload conditions, while at the same time maintaining an IG load near full capacity.)

3.2.1.2.2.2 Area of Operation. The image generator shall be capable of simulating _____ *(identify the area of operation of the application aircraft)* flight.

(The area of operation is determined by the training requirements. World wide flight versus a limited gaming area is the central issue. World wide flight generally eliminates a flat earth model and the simplifications that should accrue to it.)

3.2.1.2.2.3 Distracting Visual Effects. The image generator shall be designed so as to minimize the occurrence of distracting visual effects. Distracting visual effects shall be limited to _____*(insert number, typically 3-10)* occurrences per hour training period, and shall have a maximum duration of _____ *(insert number, typically 1-5)* seconds. Distracting visual effects shall include the following:

(Identify, and clearly define distracting visual effects requirements in this paragraph to prevent misinterpretation. This would include a listing of items that classify as a distracting visual effect. Such a listing may include image breakup, image dropout, streaking, flashing, noise, and/or discontinuities of any part of the visual image, staircasing, quantization, scintillation, and any other spatial aliasing effects; abrupt changes in image detail, apparent movement of objects in the scene due to detail transitions, repetitive or periodic motion of the visual scene not computed in the host simulator flight system; foreign image detail, static or dynamic patterns, lines separating different colors on curved shaded surfaces, and abrupt shifts in color, texture or ambient brightness of a display window or subset. Distracting visual effects must be minimized but they cannot reasonably be eliminated.)

3.2.1.2.2.4 Transport Delay. Visual system transport delay shall be defined as the interval from the time that ownship position and attitude data are available at the input to the image generator until the time that the display of the first field of the new image computed from that information is complete. Transport delay shall not exceed _____*(specify the maximum allowable visual transport delay; typically 100-150)* milliseconds during normal processing.

(Normally, transport delay should be specified at the system level and not at the segment level. If there is any unique segment transport delay requirement, it should be identified here.)

3.2.1.2.2.5 Update Rate. The image generator shall compute a new scene from the visual environment using a new position and attitude update at least _____*(insert number, typically 30 or 60)* times per second to assure a smooth dynamic response to all ownship and moving model maneuvers.

(In order to provide a smoothly moving picture with no objectionable stepping, the update rate needs to be specified. Failure to update the eyepoint at least 30 times per second will result in visible stepping and flicker in the visual scene. Aircraft performance and training requirements should be carefully examined when this value is being chosen. For highly interactive tasks such as aerial refueling or air-to-air combat, an update rate of 60 is desirable.)

3.2.1.2.2.6 Visual Simulation Dynamics. The image generator shall have the capability to provide imagery consistent with all velocities and accelerations within the performance envelope of the _____*(insert application aircraft type)* MSS for all normal and emergency maneuvers. The image generator shall be capable of simulating the motion of other moving models with the proper translational and rotational rates.

(The purpose of this paragraph is to ensure that the image generator can react with the appropriate speed to eyepoint changes due to ownship dynamics. This paragraph should also address any types of sensor systems that may require simulation if applicable. They may include infrared, laser, low light level television, electro-optical video and others.)

3.2.1.2.2.7 Channels. The image generator shall provide _____ *(insert number of channels)* channels. The channels shall be positioned with respect to the _____ *(insert reference eye-point)*.

(Channels are an architectural phenomena used by current IGs to increase Field-Of-View pixel resolution, or to provide independent eye-points. The channel requirement defined in this paragraph must be consistent with the channel display requirement defined in paragraph 3.2.1.2.12 of this specification. Future display technologies may make obsolescent the need for channel definitions.)

3.2.1.2.2.8 Special Effects. The image generator shall provide the ability to generate special effects as follows: _____ *(insert any special effects required of the IG)*.

(Special Effects are those that are not described as lighting or environmental simulation effects. This would include visual effects such as smoke trails, explosions, and localized smoke screens.)

3.2.1.2.3 Moving Models Function. The moving model function shall receive moving model interfaces and develop the scene content for all moving model imagery. This function shall

provide the visual scene content performance characteristics for all moving models required for the application. The type of model, its position and type of path or trajectory in the visual scene shall be determined by the moving model function from the interface as defined in Volume I, Appendix A of the Interface Definition Document (IDD). The outputs of this function are used by the IG and other internal functions of the Visual segment.

(Moving models may include companion and friendly aircraft, tanker aircraft, hostile aircraft, (all with their associated lighting), missiles, missile plume images, gunfire, tracers, flares, decoys, ground and sea based vehicles with running lights, helipad equipped vehicles, slingload cargo, air drop/pickup cargo, ship wake, waves, arresting barrier positions, and explosions. Each of the moving models should be defined in terms of fidelity of portrayal and in rotational and translational movement. Overly sophisticated flight dynamics or trajectories can result in system performance impacts without a corresponding training benefit. For example, the requirement for an articulated boom on a tanker aircraft moving model, if any, should be defined in this paragraph.)

3.2.1.2.4 Visual Database Function. The Visual Database function shall manage visual scene content required for display by the Visual segment. This function shall provide the capability for processing visual data at any point on the globe. It shall control storage and retrieval for the Visual segment dynamic scene content within the gaming area. The Visual Database function is a service function, reference Volume I, Section 3.2.2.1. The Visual Database function shall produce outputs to other segments, via the MSS VNET, in accordance with the interface requirements specified in the _____*(application aircraft type)* MSS IDD.

(The Visual Database function is a service function, and therefore may be implemented in another segment. If this function is allocated to a different segment (i.e. the Environment segment in the generic MSS), it should be identified as "Not Applicable" and the reader should be directed to the appropriate segment's specification for requirements. The function requirements should not be referenced in two different segments. If the primary goal of the simulation is autonomous operation, then this function may exist exclusively in the Visual segment. If a continuous "World Wide Flight" visual capability is required, then it should be stated in this paragraph. The storage requirements specified in Volume I may require modification to allow sufficient storage capability to support the extensive database requirements.)

3.2.1.2.5 Visual Scene Environment Function. The visual scene environment function manages the visual scene content to be displayed by the Visual segment. It shall provide the management of the visual scene from the Visual segment's interface defined in the _____*(insert application aircraft type)* IDD.

(The IDD will list the environmental controls required and define the interface from the IOS to the visual segment. The following subparagraphs should contain the required parameter range for each applicable control listed in the IDD. Any atmospheric simulation capabilities identified in subparagraphs must be coordinated with the IOS segment requirements.)

3.2.1.2.5.1 Atmospheric Simulation. The image generator shall have the capability to provide the following simulated atmospheric conditions.

(This paragraph introduces the requirement for simulated visibility and atmospheric effects and generally will not require tailoring)

3.2.1.2.5.1.1 Ambient light. The image generator shall provide simulated light levels for _____*(typically day, dusk, dawn, and/or night would be inserted here)* conditions, to be controllable by the instructor. Sun illumination angle shall be controllable, and the effects of sun angle shall be portrayed on all features in the visual scene.

(This paragraph must ensure that the image generator can provide appropriate illumination effects for the required ambient light levels. If daytime simulation requirements are minimal or nonexistent, a less expensive generator can be used. Elimination of a daytime capability can have significant cost savings.)

3.2.1.2.5.1.2 Haze/Visibility. The image generator shall simulate the effects of reduced visibility due to atmospheric conditions. Visibility attenuation shall be computed for all features in the visual scene for all visual tasks. Haze/Visibility shall be controllable over a range of _____*(specify visibility dynamic range, typically 0-25 miles)* in _____*(specify the resolution of visibility control)* increments.

(This paragraph should define the reduced visibility capabilities of the image generator. The resolution of visibility control may be separate values for several ranges - for example, 1000-foot increments for 0 to 2 miles and 1-mile increments for 2 to 25 miles.)

3.2.1.2.5.1.3 Clouds. The image generator shall simulate clouds and overcast conditions. Textured cloud portrayal shall be used to enhance relative motion cues. Cloud conditions shall include as a minimum; clear, overcast/smooth, and overcast/rugged (scud). Cloud thickness shall be controllable in _____*(insert number, typically 1000 feet)* increments over the range of _____ _____*(insert number, typically 1000 to 20,000 feet)*. Cloud ceiling shall be controllable in _____ *(insert number, typically 100 feet)* foot increments over the range of _____ *(insert number for cloud ceiling low range, typically 0 to 15,000 feet)* and in _____*(insert number, typically 1000 feet)* increments over the range of _____*(insert number for cloud ceiling high range, typically 15,000 feet to aircraft service ceiling).*

(This paragraph should define the cloud effects capabilities of the image generator. Any unusual cloud conditions should also be specified here.)

3.2.1.2.5.1.4 Horizon. The horizon shall be simulated for all ambient light conditions. The day horizon shall be simulated to include atmospheric light dispersions. The night horizon shall consist of a band of illumination which decreases in intensity as it extends upward from the horizon. All features in the scene shall exhibit fading effects, as a function of range, toward a controllable color shade at the horizon.

(Define the simulated horizon effects in this paragraph. Ambient lighting conditions previously identified need to have a horizon requirement specified here. If there are dusk or dawn ambient lighting conditions, identify their respective horizon requirements. If there are no daylight conditions required in the simulation, delete the day horizon reference.)

3.2.1.2.6 Lighting Control Function. The Lighting Control function manages all lighting that appears in the visual scene provided on the Visual segment's display system. It shall provide the management of the visual scene lighting from the Visual segment's interface defined in the _____*(insert application aircraft type)* IDD.

(The IDD will list the lighting controls required and define the interface from the IOS to the Visual segment. This paragraph should contain the parameter range for each applicable control listed in the IDD. Examples of lighting controls to be considered in this paragraph are: Ambient lighting (day/night), Airfield lighting (runway lights, VASI lights), Moving Model lights (navigation lights, rotating beacons, tanker boom nozzle lights), and Ownship lighting (taxi/takeoff lights). This paragraph should also address any unique procedures associated with the various special purpose lighting requirements (e.g. approach light strobe frequency, rotating beacon turn rate).

3.2.1.2.7 Spatial Relations Function. The Spatial Relations function shall calculate the linear distance between the ownship and entities external to the ownship. This function shall also calculate the linear distances between external entities within the gaming area. External entities shall include: airborne vehicles, surface vehicles, terrain or terrain features. Terrain characteristics shall be contained in the _____*(specify the terrain database source)* database. The Spatial Relations function shall detect the occurrence of collisions between the ownship and external entities. Spatial relation data shall be provided to the MSE Interaction function (Environment segment paragraph 3.2.1.15) during MSE operations. Spatial Relations is a service function, reference Volume I, 3.2.2.1. Data shall also be provided to the support function for output on the MSS VNET in accordance with the requirements specified in the _____*(insert application aircraft type)* IDD.

(The Spatial Relations function is a service function, and therefore may be implemented in another segment. If this function is allocated to a different segment (i.e. the Environment segment in the generic MSS), it should be identified as "Not Applicable" and the reader should be directed to the appropriate segment's specification for requirements. The function requirements should not be referenced in two different segments. Specific types of external objects which must be ranged upon should be identified. If a full range of spatial relation algorithms is not required by a particular simulation, then this paragraph should be modified to limit the capabilities of this function. This function is also responsible for computing ownship height above terrain.)

3.2.1.2.8 Occulting Function. The Occulting function shall determine the line-of-sight continuity between the ownship and entities external to the ownship. This function shall also determine occulting status between external entities. The Occulting function shall model visual, radar, and radio signal occulting characteristics in accordance with the signal attributes and terrain characteristic within the area of interest. Occulting is a service function, reference Volume I, 3.2.2.1. Occulting status shall be provided to other segments, via the MSS VNET, as defined in the _____*(application aircraft type)* IDD.

(The Occulting function is a service function, and therefore may be implemented in another segment. If this function is allocated to a different segment (i.e. the Environment segment in the generic MSS) , it should be identified as "Not Applicable" and the reader should be directed to the appropriate segment's specification for requirements. The function requirements should not be referenced in two different segments. Specific visual occulting requirements should be identified in this paragraph if applicable.

3.2.1.2.9 Mission Computer/Display Processor Interface Function. The mission computer/display processor interface function shall provide the backdoor or other interfaces between the simulation of operational image generation systems and the actual aircraft mission computers or displays. The video format and channel control interfaces between the mission computer, display processor and the Visual segment shall be provided by the mission computer/display processor interface function. The Visual segment IG shall deliver video signals for display on the Multi-Function Displays (MFDs) and or other cockpit display devices. These video signals shall be received by the mission computer and/or the display processor for signal processing and control.

(Identify application specific mission computer/display processor interfaces with the image generation system(s) in this paragraph.)

3.2.1.2.10 Visual Crew Station Interfacing Function. The visual crew station interfacing function shall process the display controls of crew station profile view type equipment.

Operational control of crew station or cockpit displays that interface with the Visual segment shall be accomplished in this function.

(Identify application specific mission crew station interfaces in this paragraph. The visual crew station interfacing function shall provide for crew station interfacing when FLIR/IRST and/or other types of equipment displays are simulated by the Visual segment and the controls or panels are not connected locally. Operational controls of equipment would include brightness, contrast, on/off controls, etc. If no crew station control and display interfaces are required in an application, this paragraph should be identified as "Not Applicable".)

3.2.1.2.11 Visual Aircraft Systems Interface Function. The visual aircraft systems interface function shall provide the interface between the Visual segment and simulated flight station aircraft systems. It shall process Visual segment input interfaces from the MSS Virtual Network defining the status (i.e. electrical power on/off) of aircraft equipment associated with the Visual segment. The visual aircraft systems interface function shall provide the aircraft equipment status via the Visual segment's interface defined in the _____*(insert application aircraft type)* IDD.

(Identify interface requirements of aircraft systems/equipment that are associated with the Visual segment. The electrical power status of aircraft systems such as landing lights, FLIR, and LLTV would be communicated to the Image Generator through this function.)

3.2.1.2.12 Visual Display Systems Function. The visual display systems function shall provide the actual out-the-window visual scene display and/or profile view type equipment (FLIR) display(s) as generated by the image generator function.

The visual display system function shall comply with the following performance characteristics:

a. Number of Channels:
_____*(Typically 1 to 4, must agree with IG)*

b. Maximum Instantaneous Field_Of_View *(Specify the FOV as seen from the design eyepoint. Out-the-window imagery to support Air-to-Air combat entails large Field Of View (FOV) requirements approaching 360 degrees Horizontal by 120 degrees vertical. Takeoff and Landing entails lesser FOV on the order of 200 degrees horizontal by 50 degrees vertical. Aerial refueling requirements are generally somewhat less or equivalent. Aircraft display systems normally have narrow fields of view and can be accommodated by a single channel.)*:
_____ degrees horizontal *(typically, around 48 degrees or more per channel)*
_____ degrees vertical *(typically, around 36 degrees or more)*

c. Minimum Total Field_Of_View *(specify the FOV that can be seen by moving the eyepoint around the viewing volume/exit pupil.)*:
_____ degrees horizontal *(can be the same as Instantaneous if the entire window is visible)*
_____ degrees vertical *(can be the same as Instantaneous if the entire window is visible)*

d. Resolution /Modulation Transfer Function (MTF) *(The Resolution and MTF determine to a large extent how much detail is visible and how sharp the picture is. Resolution is primary specification and will often drive the selection of both the display system and the image generator.)*:
_____ arc_minutes of Resolution *(Resolution is basically a measure of pixel size as displayed to the viewer. A Resolution of 3 arc_minutes is very good.)*

MTF at channel display center *(It should be possible for a display to draw black and white bars (optical line pairs) that are each the same size as a pixel or some combination of pixels. For a specific optical line pair distance, the MTF % refers to the % of white that is displayed. In the best case, the pixel sample points fall in the center of each bar and the pixels will be fully black or white (i.e. 100% modulation). In the worst case, the sample points fall on the edge of the bars and each pixel is half white and half black which will result in all of them being grey (i.e. 0% modulation). The best way to ensure that adequate MTF is obtained is to specify a matrix of modulations that varies the optical line pair distance.)*:
MTF near the center of each display within a circle equal to picture height *(Specify the MTF near the center of each display)*:
_____ % MTF at _____ arc_minutes/line pair
_____ % MTF at _____ arc_minutes/line pair
_____ % MTF at _____ arc_minutes/line pair

MTF five degrees from any corner of each display outside a circle equal to picture height *(Specify the MTF near the corner of the display)*:
_____ % MTF at _____ arc_minutes/line pair
_____ % MTF at _____ arc_minutes/line pair
_____ % MTF at _____ arc_minutes/line pair

e. Minimum Highlight Brightness *(specify the minimum value of the maximum brightness of a white spot located directly in front of the nominal eye position)*:
_____ foot lambers *(could range from 0.5 to around 6; a brightness of 6 is often unattainable on commercially available systems)*

f. Brightness Uniformity *(specify the maximum allowable brightness variation of any point on the display when compared to the Minimum Highlight Brightness)*:

_____ percent *(20% would be very good, worst-case would be 50%)*

g. Contrast Ratio *(specify the minimum ratio of peak white brightness to black brightness)*:
_____ *(A ratio of 30:1 would be a high contrast ratio which many display systems could not support. A ratio of 20:1 may be more obtainable.)*

h. Color Convergence *(specify the accuracy of primary color convergence within a circle of a diameter equal to the picture height)*:
_____ arc_minutes within the circle
_____ arc_minutes outside the circle

i. Viewing Volume/Exit Pupil *(Specify the radius around the viewers eyepoint in which there will be no distorted visual scene.)*:
_____ Radius in inches *(A 6 inch radius sphere is usually sufficient for fighter aircraft applications where the pilot's movement is restrained. It is often desirable to have a larger exit pupil on a wide-body aircraft. However, 6 inches remains a typical specification. Some types of displays do not have a symmetrical exit pupil, and therefore it will not be a sphere. In these cases, the vertical and lateral head/eye movement should be specified independently.)*

j. Geometric Distortion *(specify the allowable geometric position error expressed as a percentage of picture height)*:
_____ percent of picture height within the FOV *(typically 2% to 4%)*

k. Collimation Quality *(For a collimated display, the image presented at the nominal eyepoint shall be displayed near infinity. It is not possible to achieve perfect collimation, so specify the allowable collimation errors for diopters divergent, diopters convergent, and milliradians dipvergence. A diopter is expressed as the inverse of the focal length (measured in meters))*:
_____ diopters divergent *(Divergence results in an object appearing closer than infinity. Some divergence is visually acceptable. A typical divergence display requirement is -0.1 diopters.)*
_____ diopters convergent *(Convergence results in objects appearing further than optical infinity. Convergence "forces" the eyes to turn outwards and can result in discomfort. Since the eye cannot tolerate convergent rays, specifications should be written to minimize convergent rays at the expense of divergent rays. A display convergence of +0.02 diopters is usually acceptable.)*
_____ milliradians dipvergence *(Dipvergence is measured in milliradians and represents a difference in apparent elevation angle between the rays entering each eye. Only a small amount of dipvergence can be tolerated by the eye. A typical dipvergence requirement is 4 milliradians.)*

l. Video Signal-to-Noise ratio *(Specify the signal-to-noise ratio as measured at the output of the final amplifier of the video display device.)*:

_____ *(Typical values would be 39 or 40 dB if practical)*

m. Blemishes *(Specify the allowable defects in the CRT screen, envelope, display optical package, or projection screens.)*:
_____ Maximum Blemish Size *(A typical maximum blemish size is 6 arc_minutes)*
_____ Number of Blemishes Larger than _____ *(Identify the maximum number of defects above a specified size. Typically, no more than five defects larger than 3 arc_minutes should appear anywhere within the active picture area.)*

n. Image Continuity *(Specify the accuracy of image matching across boundaries such as multiple display units or multiple image sources such as projectors.)*:
_____ degrees *(A typical image continuity requirement would be 0.5 degrees. Visual systems with wide gap angle are more tolerant of image discontinuities. Simulators which require tracking of targets such as air-to-ground weapon or air-to-air combat tasks require excellent continuity.)*

o. Display Refresh Rate *(Specify the refresh rate in order to provide a smoothly moving picture with no objectionable flashing.)*:
_____ Hz *(A 30 per-second refresh rate with 2:1 interlace is typical for raster display systems with a standard CRT phosphor and average brightness.)*

(Particular care should be exercised in over specifying brightness, color convergence, and geometric distortion if a projection system has been specified as these systems are somewhat limited in those areas. Also, be sure to correlate display performance with that of the Image Generator. If multiple displays are required, each one needs to be specified separately.)

3.2.2 System Capability Relationships. The Visual segment shall support the capability relationships defined in Volume I of this specification. Visual segment functional relationships shall be as described in the following paragraphs.

(Define any Visual segment unique capability relationships. In general, the capability relationships specified in Volume I will suffice for this segment.)

3.2.2.1 Segment Functional Relationships. The top level, typical, Visual segment functional relationships are depicted in FIGURE 1. Each function shall operate in a manner which will allow the segment, as a system, to satisfy the timing requirements described in Volume I of this specification. Functions implemented within the Visual segment shall operate in such a manner which will allow the segment to meet both segment and system level requirements without degradation.

(There are two approaches to describing intra-segment interfaces: all functions communicate through the support function, or all functions communicate directly with other functions.

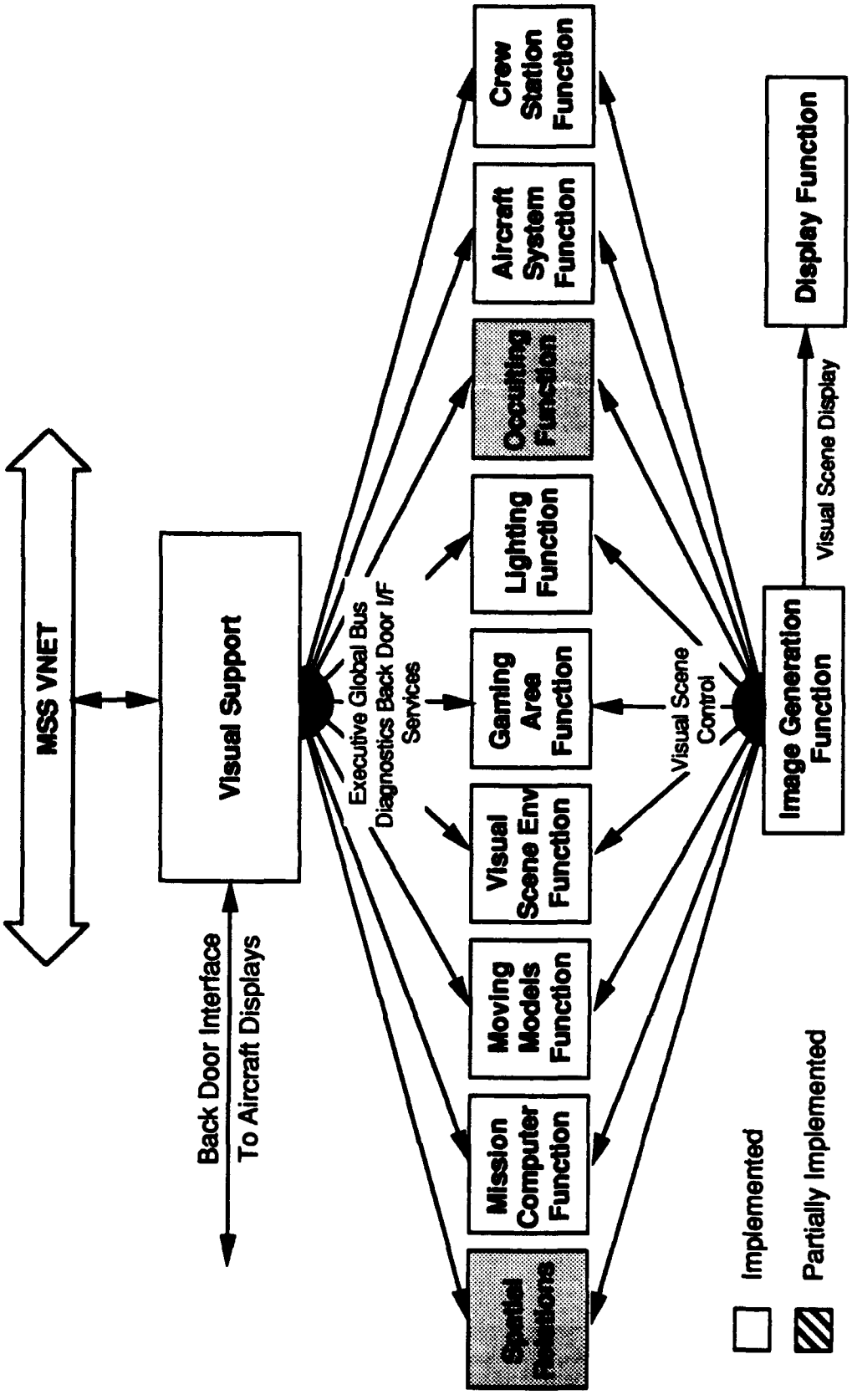

FIGURE 1 VISUAL SEGMENT FUNCTIONAL RELATIONSHIPS

FIGURE 1 in all segments may have the same structure. For this segment, functions which are not implemented should be shaded out. If desired, functions which are only partially implemented may be graphically represented with cross hatching. Note that the intent of this diagram should be to identify "required" internal relationships and not to specify the segment's internal design. The tailoring of this paragraph should be done very carefully.)

3.2.3 External Interface Requirements. The Visual segment shall support the external interface requirements defined in Volume I of this specification and the _____ *(insert application aircraft type)* MSS Interface Requirements Specification (IRS), _____ *(insert IRS document number)*. External interfaces comprise of data passed between functions contained in the Visual segment and functions of other MSS segments. With the exception of the dedicated interfaces for the cockpit or external facilities, all other external interfaces which shall be used for the Visual segment are specified in the _____*(insert application aircraft type)* IRS.

(Define any Visual segment unique external interface requirements. External facility interfaces for primary power, cooling, floor space, etc., should be identified here or specifically referenced in Volume I.)

3.2.4 Physical Characteristics. The physical characteristics of the Visual segment shall meet the requirements as specified in volume I of this specification. The Visual segment physical characteristics shall be of such design as to interface with the other MSS segments via the MSS VNET.

(Physical characteristics requirements for the Visual segment, other than those provided by the Visual segment computational system and its interface to the MSS Virtual Network shall be defined in subsequent paragraphs. Physical characteristic requirements may include backdoor interface hardware to connect Visual segment (I/O) to the application aircraft cockpit; in particular, backdoor hardware interfaces may be required for profile type view equipment such as FLIR or LLTV located in the Flight Station cockpit. In addition, any weight or size considerations applicable to the Visual segment should be considered.)

3.2.4.1 Protective Coatings. Visual segment protective coatings shall be as defined in Volume I of this specification.

(Additional protective coating requirements which are required for the Visual segment may be defined in this paragraph. Any protective coatings required for lenses in projectors, mirrors in the display system, etc. if required, would be identified here. The requirements of Volume I may suffice for the entire system.)

3.2.4.2 Image Generation Function Physical Characteristics. The physical characteristics for the IG function shall include, in addition to those provided by the Visual segment computational system and its interface to the MSS Virtual Network, image

generation and physical interfaces. The IG and physical interfaces shall meet the following physical requirements:

a. Shall be compatible with the Out-the-Window (OTW) display system.

b. Shall have Flight Station physical interface compatibility with the Multi-Function Display(s) (MFD) and or/other cockpit display system(s).

c. The IG hardware, including all components, shall not exceed _____ lbs. The IG hardware shall have a foot print of no larger than ____ sq. ft. and a maximum concentrated loading of no more than ____ lbs. per sq. ft.

d. The IG hardware shall not limit or interfere with the operational envelope of the motion system or any other system of the MSS or facility.

(The above requirements involve the video, facility and motion system interfaces. The video interface requirements must be consistent with the display processor and crew station interface functions. The facility and motion system interface considerations primarily involve the image generator hardware footprint and the motion system excursion envelope. Unless there are overriding facility concerns (e.g. shipboard operation), restrictive footprint requirements should be avoided to preclude elimination of certain image generators or even image generation capabilities.)

3.2.4.3 Mission Computer/Display Processor Interface Function Physical Characteristics. The physical characteristics for the mission computer/display processor interface function shall include, in addition to that provided by the Visual segment's computational system and its interface to the MSS Virtual Network, interface hardware requirements. The hardware interfaces shall be compatible with any aircraft computer/display which is the Visual segment's responsibility.

(This paragraph is completed by providing the aircraft mission computer and display processor physical characteristics (e.g. I/O transfer rates, signal format, etc.) and specifying the compatibility with the corresponding Visual segment hardware. The mission computer/display processor interface function may be a backdoor interface. If it is, it should be identified in paragraph 3.2.1.2.1.5 of this specification.)

3.2.4.4 Visual Crew Station Interfacing Function Physical Characteristics. The physical characteristics for the visual crew station interfacing function shall include, in addition to that provided by the Visual segment's computational system and its interfaces to the MSS Virtual Network, hardware interface requirements. The hardware requirements shall be compatible with

any aircraft display equipment which is the Visual segment's responsibility.

(This paragraph is completed by providing controls and displays physical characteristics for any profile view type equipment such as FLIR or IRST (e.g. I/O transfer rates, signal format, etc.) and specifying the compatibility with the corresponding Visual segment hardware. The visual crew station interfacing function may be a backdoor interface. If it is, it should be identified in paragraph 3.2.1.2.1.5 of this specification. If no profile view type equipment is required, this paragraph would be identified as "NA".)

3.2.4.5 Visual Display Systems Function Physical Characteristics. The physical characteristic requirements for the visual display systems function shall include the following:

a. The display system type shall be _____. *(When specifying the type of display system, the mission training requirements should be the determining factor. Air-to-Air combat training is best supported by dome or helmet mounted displays while aerial refueling training can be supported by limited or narrow field of view systems such as mirror beam splitters, direct view or infinity optics projection systems.)*

b. The number of display system channels shall be _____. *(The number of channels must be consistent with the channel processing requirements defined in the image generation function.)*

c. The physical interface to the displays shall be _____. *(The display interface is usually dictated by the display system characteristics and the image generation output is converted accordingly.)*

d. Display optics shall include _____. *(If three dimensionality and realism are requirements, then infinity optics should be specified. Otherwise, direct viewing systems with no mirrors could suffice. In general, flight training applications should have infinity optics.)*

e. The Display system(s) shall be enclosed in a lightproof shroud to permit operation in a lighted facility. The shrouding shall prevent loss of air conditioned ambient air provided by the simulator cockpit air conditioning unit in the event that windscreens are removed to improve optical effects. *(Include this requirement for any display system which includes optical elements. A light-tight area is needed so that room lighting does not adversely affect the visual display. Dome type display systems do not require shrouding in the conventional sense.)*

3.2.5 Visual Segment Quality Factors

3.2.5.1 Reliability. The system level reliability requirements applicable to all segments in the MSS are defined in Volume I of

this specification. The Visual segment reliability must be _____ % to satisfy the system level reliability requirements. The Mean Time Between Critical Failure (MTBCF) shall not be less than _____ hrs.

(A specific allocation of reliability (e.g. MTBCF) for this segment should be specified in this paragraph. Reliability should be allocated to each segment in such a way that system level reliability requirements will be met. Normally, this means that segment reliability will be higher than system reliability.)

3.2.5.2 Maintainability. The system level maintainability requirements applicable to all segments in the MSS are defined in Volume I of this specification. The Visual segment shall have a mean corrective maintenance time, of ____ minutes, and a 90th percentile maximum corrective maintenance time of ____ minutes to satisfy the system level maintainability requirements.

(Maintainability requirements such as Mean Time To Repair (MTTR) should be allocated to each segment in such a way that system level maintainability requirements will be met. Normally this means that segment MTTR will be higher than system MTTR. System Level requirements will include isolation to a faulty segment.)

3.2.5.3 Availability. The system level availability requirements applicable to all segments in the MSS are defined in Volume I of this specification.

(Usually, availability applies only to the system level. Reliability and Maintainability (MTBF and MTTR) must be allocated to each segment in such a way that system availability requirements will be met. It would be unusual to impose an availability requirement at the segment level.)

3.2.5.4 Additional Quality Factors. The additional quality factors, as defined in Volume I of this specification, shall apply to Visual segment.

(Additional Visual segment unique quality factors may be defined in this paragraph. In general, the system level additional quality factors will suffice for the Visual segment.)

3.2.6 Environmental Conditions. The environmental conditions requirements, as defined in Volume I of this specification, shall apply to Visual segment.

(Unique environmental requirements for the IG or display may exist in addition to the system level requirements. For example, Visual segment requirements for temperature, humidity, or filtered air may exceed those specified at the system level. Identify any Visual segment unique environmental requirements in this paragraph.)

3.2.7 Transportability. The transportability requirements, as defined in Volume I of this specification, shall apply to Visual segment.

(Identify any Visual segment unique transportation requirements. There may exist unique transportation requirements for Visual segment components (i.e. mirrors, projectors, lens, etc.) for shipping the segment from the segment contractors facility to the prime contractors facility. In general, the system level transportability requirements will suffice for the Visual segment.)

3.2.8 Flexibility and Expansion. The flexibility and expansion requirements, defined in Volume I of this specification, shall apply to the Visual segment.

(Expansion requirements should consider the likelihood this segment will need to change as well as the cost of including capability now versus cost to change later. Reuse of the segment in future applications should also be considered and specified. IG polygon processing capacity, display FOV, and the number of visual channels are some items that may be specified at greater than required levels in order to allow for future expansion possibilities.)

3.2.9 Portability. The portability requirements, defined in Volume I of this specification, shall apply to the Visual segment.

(Except for field transportable trainers portability of hardware is usually not a requirement. Portability of software may be a concern for future changes which may include upgrading the Computer Hardware Configuration Item (HWCI) are considered likely. Use of a standard higher order language such as Ada is usually adequate to assure software portability.)

3.3 Design and Construction. The design and construction requirements, defined in Volume I of this specification, shall apply to the Visual segment.

(Identify any Visual segment unique design and construction requirements. For example, depending on the application, when physically mating a display system and its structure to the cockpit, the system should be prohibited from interfering with windscreens, glare shields, panels, panels and cockpit structural framework. The display structure and mounting must ensure that optical properties and alignment is unaffected by cockpit motion and that damage is prevented under extreme loading associated with motion system failure. The system level design and construction requirements may suffice for the Visual segment.)

3.3.1 Materials. The materials requirements, defined in Volume I of this specification, shall apply to the Visual segment.

(Identify any Visual segment unique materials requirements. In general, the system level materials requirements will suffice for the Visual segment.)

3.3.1.1 Toxic Materials. The toxic materials requirements, defined in Volume I of this specification, shall apply to the Visual segment.

(Identify any Visual segment unique toxic materials requirements. In general, the system level toxic materials requirements will suffice for the Visual segment.)

3.3.2 Electromagnetic Radiation. The electromagnetic radiation requirements, defined in Volume I of this specification, shall apply to the Visual segment.

(Identify any Visual segment unique electromagnetic radiation requirements. In general, the system level electromagnetic radiation requirements will suffice for the Visual segment.)

3.3.3 Nameplates and Product Marking. The nameplate and product marking requirements, defined in Volume I of this specification, shall apply to the Visual segment.

(Identify any Visual segment unique nameplate and product marking requirements. In general, the system level nameplate and product marking requirements will suffice for the Visual segment.)

3.3.4 Workmanship. The workmanship requirements, defined in Volume I of this specification, shall apply to the Visual segment.

(Identify any Visual segment unique workmanship requirements. In general, the system level workmanship requirements will suffice for the Visual segment.)

3.3.5 Interchangeability. The interchangeability requirements, defined in Volume I of this specification, shall apply to the Visual segment.

(Identify any Visual segment unique interchangeability requirements. In general, the system level interchangeability requirements will suffice for the Visual segment.)

3.3.6 Safety. The safety requirements, defined in Volume I of this specification, shall apply to the Visual segment.

(Identify any Visual segment unique safety requirements. In general, the system level safety requirements will suffice for the Visual segment.)

3.3.7 Human Engineering. The human engineering requirements, defined in Volume I of this specification, shall apply to the Visual segment.

(Identify any Visual segment unique human engineering requirements. In general, the system level human engineering requirements will suffice for the Visual segment.)

3.3.8 Nuclear Control. The nuclear control requirements, defined in Volume I of this specification, shall apply to the Visual segment.

(Identify any Visual segment unique nuclear control requirements. In general, the system level nuclear control requirements will suffice for the Visual segment.)

3.3.9 System Security. The system security requirements, defined in Volume I of this specification, shall apply to the Visual segment.

(Identify any Visual segment unique system security requirements. In general, the system level system security requirements will suffice for the Visual segment.)

3.3.10 Government Furnished Property. Government Furnished Property (GFP) shall be as identified in Volume I of this specification.

(Identify any Visual segment unique GFP requirements. In general, the system level GFP requirements will suffice for the Visual segment.)

3.3.11 Computer Resource Reserve Capacity. The system level reserve capacity requirements applicable to all segments in the MSS are defined in Volume I of this specification.

(In addition to the computer resource reserve capacity identified in Volume I, the specific reserve capacity for the Visual segment may include the computational system hardware and software required to design, develop, and test the Visual segment. System considerations such as spare (time, memory, storage, I/O channels) for growth unique to this segment should be imposed here. If this paragraph requires subparagraphs they should follow the numbering and topics used in Volume I.)

3.4 Documentation. The documentation requirements, defined in Volume I of this specification, shall apply to the Visual segment.

(Identify any Visual segment unique documentation requirements. Documentation requirements for the Visual segment may include interface specifications and design data for interfacing to an embedded piece of profile type visual equipment (i.e. FLIR). Vendor documentation such as alignment and test manuals may also be included in this paragraph. The system level documentation requirements may suffice for the Visual segment.)

3.5 Logistics. The system level logistics requirements for the Visual segment shall be as specified in Volume I of this specification, paragraph 3.5, and all subparagraphs of paragraph 3.5.

(Unique support requirements for this segment should be described here or in subsequent paragraphs. These may include special tools and jigs for installation, alignment and

calibration; special environmental conditions for operation and repair such as a clean-room for component repairs; levels and types of spares required.)

3.5.1 Maintenance. Modularized construction techniques and maintenance test points shall be incorporated into the display system. Recommended cleaning procedures for all optical elements in the display system shall be established, and a dustproof enclosure shall be provided to prolong the useful life of the visual display system.

(This requirement is needed to ensure that the visual system can be aligned and maintained easily. It could be tailored for specific display configurations. For example, in the case of multiple-window displays, it may be wise to require the ability to remove display electronics for each window separately without disturbing the alignment of the other units.)

3.5.2 Remote Alignment Control. The primary visual display alignment controls shall be easily accessible for maintenance. It shall be possible to view the displayed scene either directly or indirectly (for example, reflected from a mirror) during alignment. If multiple display units are used, a remote alignment box shall be provided so that any display can be aligned while viewing the display from the pilot's eye position. A jack (or multiple jacks if necessary) shall be provided in the cockpit so that the remote alignment box can be removed and stored when not in use.

(This requirement provides for adjustment of color convergence, color balance, and geometric edge matching between adjacent displays. It is a requirement for all display systems. In most applications, this paragraph will require no tailoring.)

3.6 Personnel and Training. The system level personnel and training requirements, defined in Volume I of this specification, shall apply to the Visual segment.

(Identify any Visual segment unique personnel and training requirements. In general, the system level personnel and training requirements in addition to any special visual system maintenance training requirements (number, skills and training for maintenance personnel) will suffice for the Visual segment.)

3.7 Subordinate Element Characteristics. Not Applicable.

(This volume defines requirements for a subordinate element of the MSS. In general, there will be no subordinate elements of a segment.)

3.8 Precedence. The precedence requirements for the Visual segment shall be as specified in Volume I of this specification.

4. QUALIFICATION REQUIREMENTS

4.1 Responsibility For Test and Inspection. The _____ *(insert application aircraft type)* MSS Responsibility For Test and Inspection requirements are defined in Volume I of this specification. The requirements defined in Volume I shall apply to the Visual segment.

(This paragraph may be tailored to identify additional test or inspection requirements which are specific to the Visual segment.)

4.2 Special Tests and Examinations. The system level general qualification events, levels, and methods of testing for the Visual segment are defined in Volume I of this specification. The requirements defined in Volume I shall apply to the Visual segment.

(Clearly identify which test events defined in Volume I apply to this segment. Be particularly explicit about the segment builder's responsibility during system integration and test. In some cases, verification can only be achieved in the integrated mode. A clear definition of the segment supplier's responsibility during systems integration should be contained in the SOW.

This paragraph may be tailored to identify additional test or inspection requirements which are specific to the Visual segment. The following list contains examples of special tests that may be required depending on the application specific verification requirements.

a. Image Generator Performance Tests

These tests verify IG performance prior to integration with the visual display system. Test patterns and test databases are used to verify IG capabilities such as polygon processing capacity, system lighting capacity, surface shading, and texturing.

b. Visual Display Tests

These tests verify display capabilities with IG generated test pattern data bases, terrain data bases, and moving models. Special test equipment, such as a laser theodolite or a photometer, may be utilized to verify display capabilities. Display geometry and Field Of View, brightness, contrast ratio, color convergence, and image collimation are some tests that would be identified if required.

c. Data Base Tests

These tests verify the compatibility of the visual data bases with the IG and display systems. Selected segments of the visual data bases are displayed in order to evaluate texturing effectiveness and level of detail implementation/transitions is accomplished during these tests. Data base content (i.e. cultural features/terrain

content, airfield complexes, moving models, etc.), and correlation/accuracy of data within the data bases are tests that might be identified here.)

4.3 Requirements Cross Reference. A requirements compliance cross reference matrix shall be developed to ensure requirement traceability. The requirements cross reference matrix shall be included as part of the _____*(insert application aircraft type)* MSS Prime Item Development Specification (PIDS).

5. PREPARATION FOR DELIVERY

The _____*(insert application aircraft type)* MSS preparation for delivery requirements, as defined in Volume I of this specification, shall apply to the Visual segment.

(Segment unique requirements may include packaging the segment for shipment to the integration location which could be different than packaging the system for shipment to the installation site. If requirements are imposed here, there may be test requirements for verification which must be added to Section 4.)

6. NOTES

6.1 Intended Use. The _____ *(insert application aircraft type)* MSS shall be used as an integral part of the _____ *(insert application aircraft type)* aircraft training system.

6.1.1 Missions. The Visual segment shall support the mission requirements, as described in paragraph 6.1.1 of Volume I of this specification. It shall provide the required level of fidelity in scene content and visual cues to support training task requirements throughout the complete mission profile for the _____*(insert application aircraft type)* MSS. The Visual segment shall provide sufficient Field-Of-View, image quality, and positional accuracy to support the following required mission training tasks:_____ *(Specify the mission training tasks to be supported by the Visual segment. These tasks would include: taxi, takeoff, approach, landing, cruise, aerial refueling, low level flight, air-to-air combat, air-to-ground weapons delivery, and cell flight.)* The trainees may range in experience from newly designated aviators undergoing initial training to experienced aviators undergoing refresher training.

(The Visual segment mission is to support the trainer mission as described in Volume I. Any mission specific information should be described in this section. An example would be a Visual segment intended to support a family of trainers such as a procedures trainer, part-task trainer, flight trainer, or weapons system trainer. Another example might be a requirement to support "strange field landing" training through use of generic airfields rather than specific real world military airfields.)

6.1.2 Threat. Not applicable.

(This paragraph shall describe the threat which the system is intended to neutralize. In this context, this paragraph is not applicable to most simulators, and will generally remain "Not applicable".)

6.2 Visual Segment Acronyms. The acronyms contained in this paragraph are unique to Visual segment and are in addition to the MSS acronyms contained in Volume I of this specification, paragraph 6.2.

COTS	Commercial Off-The-Shelf
DOD	Department of Defense
FLIR	Forward Looking Infrared
FOV	Field Of View
GFP	Government Furnished Property
HUD	Head Up Display
HWCI	Hardware Configuration Item

IDD	Interface Design Document
IG	Image Generator
I/O	Input/Output
IOS	Instructor/Operator Station
IR	Infrared
IRS	Interface Requirements Specification
IRST	Infrared Search and Track
LLTV	Low Light Television
MDD	Malfunction Description Document
MFD	Multi-Function Display
MTBCF	Mean Time Between Critical Failures
MTF	Modulation Transfer Function
NA	Not Applicable
OLS	Optical Landing System
OTW	Out-the-Window
REIL	Runway End Indicator Lights
RVR	Runway Visual Range
T.O.s	Technical Orders
VASI	Visual Approach Slope Indicator
VNET	Virtual Network

6.3 Glossary of Visual Segment Terms. The terms contained in this paragraph are unique to the Visual segment and are in addition to the MSS terms contained in Volume I of this specification, paragraph 6.3.

ABRUPT CHANGES IN IMAGE DETAIL - The abrupt emergence (or deletion) of image detail (in an unnatural fashion). This is sometimes referred to as "image popping".

AERIAL REFUELING - An aircraft configuration and operating mode that allows the air vehicle to receive inflight fuel on/off-loads from a tanker aircraft.

ALIASING - The name given to a wide range of undesirable visual artifacts caused by the quantization of the image into pixels. Jagged and/or crawling edges, gaps in thin polygons and a tendency for small polygons to blink on and off are typical examples.

ANTI-ALIASING - Hardware or software processes for minimizing the effects of aliasing. Typically involves subpixeling and supersampling.

AMBIENT LIGHTING - The natural or surrounding lighting external to the air vehicle. It is the result of reflections from objects and it is incident from all directions. Ambient lighting is typically modelled as a constant based on a discrete time of day and is uniform across the scene. More sophisticated systems vary ambient lighting as a function of a dynamic solar angle.

BACKFACED POLYGONS - Polygons which are facing away from the viewer/eyepoint and do not need to be processed, such as the backside of a mountain.

BEAMSPLITTER - An optical element that angularly (normally 90 degrees) reflects a projected image to a collimating mirror which the observer views through the splitter.

CALLIGRAPHIC DISPLAY - A display that can direct the electron beam flexibly and with more accuracy than raster displays. Typically used for sharp and bright rendition of light points.

CELL FLIGHT - Formation flight of the ownship with a companion aircraft.

CHANNEL - A portion of an image dedicated to an independent viewing volume. Channels are normally defined by a field of view (usually rectangular) from a defined eyepoint. Some image generators allow multiple eyepoints and even multiple image types (i.e. out-the-window, FLIR, electro-optical, etc.)

CLIPPING - The process of truncating polygons and light strings that intersect the boundaries of the viewing volume and creating temporary polygons and light strings for rendering.

COLOR AND TEXTURE SHIFTS - Transient or abrupt changes in the color or texture of the displayed image.

COMPUTER IMAGE GENERATION (CIG) - The process of algorithmically generating visual images from geometric data bases, as opposed to film systems and closed circuit television.

CONTRAST - The ratio of a full white field to completely black field or the difference between brightness of a scene element and its immediate background.

CONVERGENCE - A display distortion in which objects appear to be further than optical infinity causing the eyes to turn outwards.

DATA BASE - The geometric information that an image generator processes into an image.

DIPVERGENCE - A display distortion in which the same object is displaced vertically when viewed by both eyes.

DISPLAY SYSTEM - The portion of a visual system that presents the picture created by the image generator to the user. Display systems range from a simple CRT, which is viewed directly, to complex infinity optics systems that provide virtual images.

DIVERGENCE - A display distortion in which objects appear to be closer than optical infinity. Some amount of divergence is visually acceptable.

EXIT PUPIL - The volume about the eyepoint in which the observer can move without the loss of apparent brightness and introduction of distortion.

EYEPOINT - The point in space from which the image generator calculates its image(s). Some complex simulations will require more than one eyepoint. This may be very impactive on the IG depending on the distance between eyepoints. The simulator (and the vehicle being simulated) will have one or more design eyepoints which is the physical location where the viewer's head is expected to be. It is this point that the display system should be aimed at.

FIELD OF VIEW (FOV) - The area of the image produced by the visual system, normally expressed as a horizontal and vertical angle. The actual FOV results from the display system, but must be carefully coordinated with the image size being calculated by the image generator.

> INSTANTANEOUS - The FOV which is available to the viewer without moving his head. This may assume that the eyepoint is in the center of the exit pupil.
>
> TOTAL - The FOV achieved by the viewer moving his head to expose more image. This may involve moving the eyepoint to the extremes of the exit pupil. Any FOV view achieved by moving the eyepoint outside of the exit pupil is normally disregarded because of the resultant distortions.

FIXED SHADING - Intensity interpolation across a polygon without respect to the polygon orientation relative to a simulated solar angle.

FLAT SHADING - A technique where a polygon is assigned a single intensity to provide a faceted appearance for the scene.

FLICKER - A perceptible modulation of display luminance caused by an insufficient refresh rate.

FLASHING - A transient change of brightness, contrast or color of any portion of the visual image. Also included is the transient appearance of any subset of image that is not a part of the required presented image.

FOREIGN IMAGE DETAIL - The presence of any unnatural image texture, geometric form, highlighting, outline, or distortion of required image detail.

FORWARD LOOKING INFRARED (FLIR) - A cockpit display system utilized on some air vehicles that uses infrared radiation to provide outside visual images and references.

GEOMETRIC DISTORTION - An error in geometric position expressed as a percentage of picture height. It occurs in visual systems due to non-linearities in displays and optics.

GOURAUD SHADING - A algorithm that uses bilinear intensity interpolation between polygon vertex normals to eliminate the visibility of polygons. The polygon vertex normals are calculated as the average of the face normals of the polygons sharing the vertex. Often referred to as curved surface or smooth shading.

IMAGE BREAKUP - A transient disintegration of any portion of the visual image.

IMAGE DISCONTINUITIES - Gaps at edges of display channels on a multichannel display, or any other image discontinuity regardless of where it appears in the display.

IMAGE DROP-OUT - A transient disappearance of any portion of the visual image.

IMAGE GENERATOR - The generic term which refers to the collection of hardware used for creating computer generated imagery. The term normally implies a significant amount of special purpose hardware and real-time operation.

INSTRUCTOR/OPERATOR STATION - Provides the central point of control for the entire air vehicle trainer. The primary user of the IOS is the training instructor.

INTERLACE - The characteristic of many display devices to draw half of the raster lines during one field followed by the other half interleaved between the first set during the next field. This is referred to as the odd and even field. The eye tends to "merge" these into a complete image. Until

recently, all displays were of this type including home television sets. Many current displays can provide a full screen of raster lines for each refresh of the image (i.e. non-interlaced).

INSTANCING - The capability of some IGs to display multiple copies of an object which is stored on the disk only once. The data base will include a reference to the object along with a location and perhaps a rotation.

LOW LIGHT TELEVISION - A cockpit display system utilized on some air vehicles that uses electromagnetic waves to provide outside visual images under minimal ambient lighting conditions.

NATURAL ENVIRONMENT - The geographic and atmospheric conditions and phenomenon including lighting and magnetic field variations in which the ownship operates.

NOISE - Randomly appearing white, black, or colored dots or speckles.

OCCULTING - The hiding of polygons, or portions of polygons, as the result of intervening polygons. Also applies to the process of determining clear line of sight between entities.

OUT-THE-WINDOW (OTW) - Imagery simulating the real world as perceived by the human eye as opposed to simulated sensor imagery such as FLIR or Electro-optics.

OVERLOAD - A condition which occurs when an image generator is forced to process more than it is designed for. This can be too many polygons and/or light points, too many pixels, too many dynamic coordinate systems, too much transparency, too much occulting, etc. Overload is somewhat peculiar to real-time Computer Image Generator devices which are designed to operate at a specific rate. It is ultimately this restriction in processing time which makes overload a problem.

OWNSHIP - The host vehicle which is being simulated. Also refers to the eyepoint from which the image is calculated.

PHONG SHADING - A shading technique that provides specular reflection (highlight brightness) in the center of polygons. Interpolation is applied to the vertex normals rather than the vertex intensities as with Gouraud shading.

PIXEL - Abbreviation for Picture Element. This is the smallest unit along a raster line form which a display device can change color and/or intensity.

POLYGON - The basic element of most modern image generators. A two dimensional shape with straight sides, normally single sided, and defined by the location of its corners. Viable polygons are usually limited to convex shapes.

RASTER - The media with which a video display or projector creates its image. The picture is drawn by the electron gun(s) being swept across the inside of the cathode ray tube (usually horizontally) where it excites the phosphor to create color and intensity. The speed with which the beam(s) can be modulated to change the color or intensity will determine the number of pixels available on each raster line. Many display devices use an interlace technique which will only draw half of the raster lines at a time depending on the persistence of the eye to "assemble" the image.

REFRESH RATE - The rate at which the image is re-drawn on the display device. This is often the same as the update rate, but some systems will draw the same image more than once, giving the image generator more time to calculate the next scene.

RESOLUTION - The capability of a system to make clear and distinguishable the separate parts or components of an object or, to different between sources of light. For visual systems, a parameter that defines the resolution element size to be specified in measuring modulation transfer function.

RUNWAY VISUAL RANGE (RVR) - An instrumentally derived value that represents the horizontal distance a pilot can see down the runway from the approach end. It is reported in hundreds of feet.

SCINTILLATION - A visual artifact associated with small or thin objects whose spatial extent is less than the area of a pixel. Small objects may appear and disappear, or edges may appear to crawl.

SCUD - A visibility modulation for simulating ragged cloud tops or bottoms.

SEND ON CHANGE - A parameter or interface whose state is made public only when that state has changed.

SHADING - Any of several techniques where the intensity and color of polygons is determined from a defined light source. The most common types of shading are fixed, flat, and Gouraud (smooth).

SIMULATE - Produce a copy enough like the original so that the differences detected by the user are within a specified tolerance for a given range of use.

STATIC OR DYNAMIC PATTERNS - Transient or long term errors in image brightness, shading, or color.

STREAKING - The appearance of streaks (light or dark) which overlay or contrast with the visual image.

SUB-PIXEL - A further division of a pixel commonly used for anti-aliasing filters.

TACTICAL ENVIRONMENT - A collection of man made, initiated or controlled elements that are external to the ownship and not part of the natural environment.

TEXTURE - A technique of modulating polygon attributes such as intensity, color, transparency, etc to achieve a desired visual effect.

TRANSLUCENT POLYGON - A polygon that is partially transparent.

TRANSPARENCY - A technique that mixes the color of a translucent polygon with the color of the occulted portions of the polygons behind that polygon.

TRANSPORT DELAY - The time from image generator receipt of a control input until the completion of the first display field containing the new image.

UPDATE RATE - The rate (frames pear second) at which a new image is created by the image generator. May or may not be the same as the display refresh rate.

VERTEX - An infinitely small point in a data base normally defined by X, Y, Z positions relative to a coordinate system origin.

VIEWING VOLUME - From an image generation perspective, a rectangular pyramid with the apex at the eyepoint and truncated by the back clipping plane. From a display system perspective, the volume in which a viewer will see an undistorted image (also called the Exit Pupil).

VISIBILITY - The effect of visibility restriction as the result of atmospheric conditions. Atmospheric conditions include fog, ground fog, haze, clouds, scud, and runway visual range.

VISUAL SYSTEM - A collection of components including and image generator, data bases, a display system and host interfaces.

WINDOW - An out-the-window display channel. Not necessarily equivalent to a channel of imagery.

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XI-2	D	XI-41	D								
XI-3	D	XI-42	D								
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A	BMAC-STS-86-303-1 Total revision required to incorporate changes required by testing/validation efforts and Government comments.	90/01/11 91/01/14 91/01/14 91/01/14 91/02/15	S. Clem Prepared By Checked By Dwg. Qual. Supervised By Approved By
B	CCP HSV-H91-008 Total revision required to incorporate changes resulting from addition of two new specifications and new functional allocation. Damage Assessment and Scoring were added to the module support function. The Height Above Terrain function was deleted. The Visual Database/Gaming Area function was modified into a service function with reference to the Tactical and Natural Environments module. Smoke was added to the initial parameters list in the Visual Scene Environment function. The Fires parameter was added to the initial parameters list in the Lighting function.	91/06/26 91/06/26 91/06/26 91/06/27 91/06/27	Prepared By Checked By Dwg. Qual. Supervised By Approved By

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REVISIONS			
LTR	DESCRIPTION	DATE	APPROVAL
C	CCP HSV-H91-008 Total revision required to incorporate Government comments on document.	91-09-26 91-09-27 91/09/27 91-09-27 91-10-08	K. Kelly Prepared By Checked By Lgg. Qual. Supervised By Approved By
D	CCP HSV-H91-017 This specification volume has been totally revised to: 1. Change the format to comply with DI-CMAN-80008A. 2. Incorporate the tailoring instructions into the body of the text. The incorporation of tailoring instructions into each specification volume has caused a change in the number of specification volumes from fourteen to thirteen. Prior to this change, all tailoring instructions were provided in Volume XIII and Volume XIV contained the Tactical and Natural Environment segment specification. The content of Volume XIII has been integrated into the other specification volumes. The change is summarized as follows: Volume — IS — WAS I through XII — Titles for these volumes are unchanged XIII — Environment — Tailoring Instructions XIV — "Deleted" — Tactical and Natural Environment	93-08-23 93-08-23 93 08-23 93/08/24	PREPARED CHECKED SUPERVISED APPROVED

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